2006 RESEARCH PROBLEM STATEMENT

Problem Title: **Evaluation of Bridges for Seismic Retrofit** No.:06.08-01

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1. Briefly describe the problem to be addressed:

UDOT plans to follow the lead of other state DOTs in identifying and updating or replacing bridges that are deficient in lateral resistance. A project is proposed to explore various retrofit techniques for different classes of bridges, and develop a procedure for future retrofit evaluation. Special emphasis is to be placed on seismic isolation as a retrofit technique. This often cost-effective approach can overcome many existing deficiencies in lateral resistance with minimal modification to the structural system, and can greatly extend the life of existing bridges. Seismic isolation has been extensively applied to bridges all over the U.S, with more than 175 total bridges and more than 40 percent in low to moderate seismic regions (Aiken et. al., 2006).

Strategic Goal: ☒ Preservation ☐ Operation ☐ Capacity ☒ Safety (Check all that apply)

2. List the research objective(s) to be accomplished:

1. Develop general guidelines for preliminary evaluation of bridges to predict the necessity of seismic retrofit and the most beneficial retrofit technique, to be used as a basis for further evaluation.
2. Develop a process for detailed retrofit evaluation of individual bridges, including use of software, modeling guidelines, and a decision-making flowchart.
3. Develop instructional material on bridge isolation systems, including representative designs for specific bridges in Utah.

3. List the major tasks required to accomplish the research objective(s): Estimated person-hours

1. Conduct a thorough literature review of seismic retrofit of bridges, including retrofit and modeling techniques. Look for correlation among bridge characteristics and retrofit techniques chosen. Interview state DOTs such as Caltrans and WSDOT for insight into evaluation procedures.

2. With UDOT staff and TAC, identify 8 existing bridges in Utah for detailed study and identify suitable general purpose finite element software for research and future evaluation.

3. Evaluate the seismic resistance of each of the 8 bridges in their existing state, and evaluate various retrofit alternatives considering both cost and performance. Retrofit techniques include strengthening of critical components, displacement enhancement (increasing seat width, column confinement), force limitation, soil improvement, and seismic isolation. In this task, a simplified capacity/demand procedure will be used wherein the force or displacement capacity of each element in the lateral load path is compared with the corresponding seismic demand.

4. Verify the results from Task 3 by detailed modeling and response history analysis with an appropriate suite of ground motions for a suitable selection of retrofit alternatives, including seismic isolation. Document the process carefully, and convert to procedural guidelines for detailed retrofit evaluation.

5. Based on Tasks 3 and 4, develop general guidelines for preliminary retrofit evaluation, to predict necessity of retrofit and most probable retrofit technique based on bridge characteristics. Incorporate simplified analysis of a larger set of bridges or a parameter study if information from Tasks 3 and 4 is insufficient.

6. Develop instructional material for UDOT engineers on the design of isolation systems, which include sample designs pertinent to the case studies in Tasks 3 and 4 documented in MathCad.

7. Prepare report and conduct training session for UDOT.

4. Outline the proposed schedule (when do you need this done, and how we will get there):

The project duration is anticipated to be approximately 36 months, with the following breakdown of the above tasks:

Task 1 = 3 month
Task 2 = 1 month
Task 3 = 8 month
Task 4 = 12 month
Task 5 = 5 month
Task 6 = 3 month
Task 7 = 4 months

5. Indicate type of research and / or development project this is:

Large: ☒ Research Project ☐ Development Project
Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative ☐ Other _____

6. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University in association with UDOT staff and cost consultants

7. What deliverable(s) would you like to receive at the end of the project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.)
The deliverables are (a) a report documenting the entire research effort, (b) guidelines for preliminary seismic retrofit evaluation in bridges, (c) instructional material and examples for the design of bridge isolation systems, and (d) a process or workflow for detailed seismic retrofit evaluation including decision making and modeling techniques.

8. Describe how will this project be implemented at UDOT.
This project will be implemented by an internal evaluation of the report, and integration of the proposed design standards into a policy manual, which governs how both UDOT engineers and consultants are required to approach retrofit evaluation and seismic isolation design. The research team will conduct a training program for UDOT engineers training program for UDOT engineers illustrating the retrofit evaluation process and modeling techniques with the selected software package. At the conclusion of this project, UDOT will consider proceeding with a demonstrative seismic isolation retrofit on one of the case study bridges.

9. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be.
UDOT will benefit from by incorporating consistent evaluation and state-of-the-art seismic retrofit techniques into a bridge retrofit program. State constituents will benefit from increased safety, extended life, and long term cost savings to existing bridges. If seismic isolation is implemented, enhanced performance is expected in a seismic event.

10. Describe the expected risks, obstacles, and strategies to overcome these.
Structural systems and former construction practices for existing Utah bridges may be very diverse such that it is difficult to generalize techniques and outcomes from the case study bridges into a comprehensive evaluation program for all bridges. However, at the very least the project will be able to identify recurring classes of bridges that are at greatest risk and can benefit from a specific retrofit technique. UDOT needs to anticipate the funding needs for a long term retrofit program.

11. List the key UDOT Champion of this project (UDOT employee who will help Research Division steer and lead this project, and will spearhead the implementation of the results): Boyd Wheeler

12. Estimate the cost of this research study including implementation effort (use person-hours from No. 3):
$100,000 - $120,000

13. List other champions (UDOT and non-UDOT) who are interested in and willing to participate in the Technical Advisory Committee for this study:

Name	Organization/Division/Region	Phone
A) Boyd Wheeler	UDOT	
B) Marv Halling	USU	
C) Hugh Boyle	Consultant	
D)		
E)		
F)		
G)		

14. Identify other Utah agencies, regional or national agencies, or other groups that may have an interest in supporting this study:
FHWA